

REMARKS

Claims 7-9, 11-14 and 16-19 are pending in the present application. Claims 1-6, 10, 15 and 20-22 have been canceled.

Claims 7-9, 18 and 19 have been amended to recite that the thermoplastic resins are a thermoplastic polyurethane resin prepared by reacting a polyol compound having a number-average molecular weight of 1,000 to 5,000 with a polyisocyanate and a chain extender. Support for this amendment can be found on page 14, line 35 to page 15, line 20 of the specification. These claims have also been amended for clarity.

Claims 11, 12, 16 and 17 have been amended to be in the Examiner's preferred form by depending from claims in the alternative.

No new matter has been added by way of the above-amendment.

Claim Objections

Claim 7 stands objected to due to a misspelling of the word "fluoropolymer". In response, Applicants have corrected the misspelling.

Claims 11, 16 and 20 are objected to because the multiple claim dependency is not stated in the alternative ("and" is used instead of "or"). In response, Applicants have amended these claims so as to depend from other claims in the alternative.

Based on this response, Applicants respectfully request withdrawal of the objection.

Rejection under 35 USC 112 (paragraph two)

Claims 7-9 and 18-19 stand rejected under 35 USC 112 (paragraph two) as not distinctly claiming the invention. Applicants respectfully traverse the rejection.

The Examiner objects to the use of the term "class" in the claims.

The Examiner also objects to the use of the term "residue" in describing the thermoplastic binder.

In response, Applicants have amended the relevant portion of the rejected claims to read as follows:

~~"wherein a residue of the thermoplastic resin in the said binder composition is~~
comprises at least one other thermoplastic resin selected from the class group
consisting of . . .".

In view of the foregoing, Applicants respectfully submit that the claims, as presently amended, particularly point out and distinctly claim the subject matter which Applicants regard as the invention. Accordingly, withdrawal of the rejection is respectfully requested.

Rejections Under 35 U.S.C. § 103

The Examiner issues the following prior art rejections:

- (1) Claims 7-9, 11-12 and 18-20 stand rejected under 35 USC 103(a) as being unpatentable over Venugopal et al '959; and
- (2) Claims 7-9 and 18-19 stand rejected under 35 USC 103(a) as being unpatentable over Venugopal et al '959 in view of Katsurao et al '388.

Applicants respectfully traverse both rejections.

Applicants respectfully submit that Venugopal et al '959, either taken alone or in combination with Katsurao et al '388, do not fairly suggest the combination of: A) a thermoplastic resin which is a thermoplastic polyurethane resin prepared by reacting a polyol compound having a number-average molecular weight of 1,000 to 5,000 with a polyisocyanate and a chain extender and having a specific swelling ratio; and B) at least one other thermoplastic resin which is a fluoropolymer, a synthetic rubber, a polyolefin and a polyether.

Applicants now turn to the secondary reference of Katsurao et al. The Examiner cites Katsurao et al. for teaching that it would be obvious to add a polyvinylidene fluoride (PVDF) polymer to the polyurethane resin of Venugopal.

However, Applicants note that the PVDF described in Katsurao et al. has specific high temperature resistance properties, which is distinct from the PVDF of the present invention. An important object of the invention of Katsurao et al. is to have enhanced heat resistance of the PVDF. To achieve this object, Katsurao et al. introduce 0.1 to 5 mol. % of a monoester of unsaturated dibasic acid or an epoxy group containing vinyl monomers and chemically or physically crosslinks the polymer. See column 4, lines 23-29, column 6, lines 18-24, and column 8, line 54 to column 9, line 5.

To highlight this distinction between the PVDF polymers of Katsurao et al. and the inventive PVDF polymers, each of independent claims 7-9, 18 and 19 recite the following proviso:

“with the proviso that when the residue of the thermoplastic resin in the binder composition is a polyvinylidene fluoride, the glass transition temperature of the binder composition is lower than the freezing point of the electrolyte solution”.

Thus, the inventive compositions comprising PVDF have a *low temperature capability* which would not be seen with the high temperature resistant PVDF polymers of Katsurao et al. In fact, it is surprising that the inventive combination of a polyurethane and PVDF would have better low temperature capability than PVDF alone. In support of the non-obviousness of the inventive composition which contains a polyurethane thermoplastic resin having a PVDF residue, the Examiner's attention is directed to the exemplified embodiments within the present specification. The relevant experimental examples are shown in the following table for the Examiner's convenience:

	Positive electrode binder	Separator	Negative electrode binder	Low temperature capability (%)
Example 10 (secondary cell 9)	Polycaprolactone PU (5 wt%) + PVDF (95 wt%)	PP/PE/PP	Polycaprolactone PU (5 wt%) + PVDF (95 wt%)	87.6
Example 11 (secondary cell 10)	Polycaprolactone PU (1 wt%) + PVDF (99 wt%)	PP/PE/PP	Polycaprolactone PU (1 wt%) + PVDF (99 wt%)	75.2
Example 15 (electrical double-layer capacitor 3)	Polycaprolactone PU (5 wt%) + PVDF (95 wt%)	PTFE	Polycaprolactone PU (5 wt%) + PVDF (95 wt%)	80.2
Comparative Example 4 (secondary cell 12)	PVDF	PP/PE/PP	PVDF	60.8
Comparative Example 6 (electrical double-layer capacitor 5)	PVDF	PTFE	PVDF	71.4

Low-temperature capability (%): (discharge capacity at -10°C)/(discharge capacity at 25°C) x 100

As can be seen from the above-data, the introduction of just 1% polycaprolactone PU into the binder composition increases the low temperature capability **24%** (compare inventive Example 11 having a low temperature capability of 75.2% with Comparative Example 4 having a low temperature capability of 60.8%). Also, the addition of 5% polycaprolactone PU into the binder composition increases the low temperature capability **12%** (compare inventive Example 15 having a low temperature capability of 80.2% with Comparative Example 6 having a low temperature capability of 71.4%).

This improvement to the low temperature properties would not be expected by modifying the polyurethane compositions Venugopal with the Katsurao et al's high temperature resistant

PVDF having 0.1 to 5 mol. % of a monoester of unsaturated dibasic acid or an epoxy group containing vinyl monomers which is chemically or physically crosslinked.

In view of the above-considerations, it is clear that a *prima facie* case of obviousness cannot be said to exist over Venugopal, as taken alone or in combination with Katsurao et al. As such, withdrawal of the rejections is respectfully requested.

In the outstanding Office Action the Examiner states that the skilled artisan would reasonably find that adding the polyvinylidene fluoride of Katsurao et al to the thermoplastic binder of Venugopal et al. would naturally give improved retentivity for the powdery electrode materials and the ionic conductivity. The Examiner argues that since Applicants' finding of improved low temperature capability property does not detract from the improvements expected based on Katsurao et al., then the instant composition is still obvious. Applicants respectfully disagree. It is well settled that a showing of unexpected results will overcome a *prima facie* case of obviousness. As noted above, the inventors have not merely found a latent property of the composition. They have found a property, wherein the magnitude of the improvement in the property is unexpected. Whether there are subtle improvements in other properties expected by the combination of polyvinylidene fluoride of Katsurao et al and the thermoplastic binder of Venugopal et al. speaks to the motivation to combine the references. It does not speak to whether Katsurao et al. fairly suggest improved low temperature capability using polyvinylidene fluoride as was first found by the present inventors. Since the low temperature capability properties are unexpected based on the teachings of Katsurao et al and Venugopal et al., the experiments described above overcome a *prima facie* case of obviousness.

Furthermore, Applicants have further amended the claims so as to be commensurate in scope with the compositions having unexpectedly improved ionic conductivity under low temperatures. Venugopal et al. disclose a thermoplastic polyurethane resin having a swelling ratio 150-800%, however they disclose very wide range molecular weight of polyols, that is, the molecular weight of the soft segment in the polyurethane resin is between 300 and 10,000. [Cf. column 5, lines 57-58.] Therefore Venugopal et al. does not disclose a polyurethane resin

prepared by reacting a polyol having a number-average molecular weight of 1,000 to 5000 with a polyisocyanate, and such a polyurethane resin showing a high ionic conductivity under a low temperature. Further, Venugopal et al. are silent about change of an ionic conductivity of a battery under a low temperature, and problems brought by the conductivity change.

In the inventive battery, the thermoplastic polyurethane resin is prepared by using a polyol compound having a number-average molecular weight of 1,000 to 5000, so that the thermoplastic polyurethane resin has a swelling ratio 150-800% and a high ionic conductivity under a low temperature. [Cf. Example 1. Pracel 220N (CAS RN: 27102-04-1) has a number-average molecular weight of 2,000.]

On the other hand, the thermoplastic polyurethane resin prepared by using a polyol compound having a number-average molecular weight of more than 5,000 **does not** have a swelling ratio within the inventive range and sufficient ionic conductivity under a low temperature. [Cf. Comparative Example 1, PEG 6000S (CAS RN: 25322-68-3) has a number-average molecular weight of 8,300.] This change in ionic conductivity under low temperatures **would not be expected** based on the teachings of Katsurao et al and Venugopal et al.

Katsurao et al. are also silent about a polyurethane resin by reacting a polyol having a number-average molecular weight of 1,000 to 5000 with a polyisocyanate.

Accordingly, based on the disclosures of Venugopal and Katsurao, those skilled in the art cannot arrive at the inventive thermoplastic polyurethane resin having a high ionic conductivity under a low temperature, and also adopt the polyurethane resin to a battery so as to improve an ionic conductivity under a low temperature.

Lastly, it is noted that the Examiner appears to be incorrectly interpreting the disclosure of Venugopal et al. The Examiner states at page 7 of the Action that “Venugopal et al teaches a binder made by combining a polyurethane with a *polyether*” – which comment contrasts with the Examiner’s prior statement that the reference teaches the combination of “polyurethane and *polyester*”. In consideration of the description of column 6, lines 23-36, Applicants believe that

polyester-polyether systems and polycarbonate-polyether systems are polyurethane resins having polyester-polyether segment or polycarbonate-polyether segment in the molecules.

Therefore, Applicants do not believe that Venugopal et al. disclose a binder made by combining a polyurethane with a polyether.

Furthermore, Applicants respectfully submit that the combination of Venugopal et al. Katsurao et al. is not proper. Katsurao et al. do not fairly suggest that the vinylidene fluoride can be combined with the polyurethane of Venugopal et al. Katsurao et al. disclose the following matter.

The vinylidene fluoride copolymer may be used alone or in mixture with another polymer matrix-forming resin... [Column 6, lines 25-27.]

However, a polyurethane resin is not exemplified at all as another polymer matrix-forming resin.

Also, Venugopal et al. do not disclose that the polyurethane resin can be used in combination with a fluoropolymer.

Accordingly, those skilled in the art cannot arrive at using a polyurethane resin in combination with a fluoropolymer, as presently claimed.

Based on the foregoing, withdrawal of both rejections is respectfully requested.

In view of the above amendment, applicant believes the pending application is in condition for allowance.

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact Garth M. Dahlen, Ph.D., Esq. (Reg.


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No. 43,575) at the telephone number of the undersigned below, to conduct an interview in an effort to expedite prosecution in connection with the present application.

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Respectfully submitted,

By 

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